Content of dry matter, crude fiber, and ash in fermented rice bran with palmyra sap at different length of fermentation

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Abstract. Rice bran is one of waste products from rice processing that can be used as nonruminant feed ingredients, but high crude fiber contained limited its utilization. Reducing crude fiber content requires processing such as fermentation. Fermentation requires carbohydrates such as palmyra sap. The purpose of this research was to determine the changes in the content of dry matter, crude fiber and ash of rice bran added with palmyra sap at different fermentation periods. This research used a Complete Random Design with four treatments and five replications. The four treatments are DN0: without fermentation, DN3: 3 days fermentation, DN6: 6 days fermentation, and DN9: 9 days fermentation. The parameters measured were the content of dry matter, crude fiber, and ash. Data were analyzed using Analysis of Variance and continued with Duncan's Multiple Range Test. The results showed that fermentation periods decreased the crude fiber and ash content but had no significant effect on the dry matter content of rice bran. The 3 days fermentation period resulting the lowest crude fiber content.

1 Introduction

One of the common agricultural byproducts used as animal feed is rice bran. Rice bran has been widely utilized by most farmers in Indonesia as animal feed. Rice bran has significant potential as an energy source for livestock. It is a byproduct of rice milling in the production of rice [1]. The nutrient content of rice bran is as follows: crude protein 11.9%, crude fat 12.1%, calcium 0.1%, phosphorus 1.3%, and metabolic energy 2200 kcal/kg [2]. Rice bran contains crude fiber ranging from 12.4% to 27.8% [3], and according to Lamid et al. [4], rice bran contains 6.9% phytic acid. Pujaningsih et al. [5] reported that this phytic acid binds minerals such as calcium and phosphorus. Additionally, phytic acid can also bind to proteins, reducing protein digestibility. Both crude fiber and phytic acid can be reduced through processing methods such as fermentation [6].

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Ermalia et al. [7] reported that the fermentation of rice bran using Lactic Acid Bacteria (LAB) starter and a storage period of 12 days can reduce the phytic acid content from 6.70% to 2.07% and increase the coefficient of dry matter digestibility from 63.06% to 69.72%. Fermentation is a biochemical process involving microorganisms. One of the purposes of fermentation is to enhance the digestibility of feed ingredients [8]. The principle of fermentation involves activating the growth of necessary microorganisms, leading to the formation of new products. Anaerobic fermentation can create an acidic environment that supports the growth of lactic acid bacteria. The acidic conditions during the fermentation process can be modified using various easily fermentable carbohydrate sources as additives [9].

One of the additives used is palmyra sap or "nira lontar." Nira lontar is a liquid tapped from the male flowers of the lontar palm tree, containing sugar content ranging from 10-15% [10]. Nira lontar contains fructose at 4.0%, glucose at 3.5%, and sucrose at 3.6%[11]. The high sugar content in this substance serves as a food source to stimulate the growth of lactic acid bacteria capable of breaking down the components of crude fiber during the fermentation process. The fermentation duration is one of the most crucial factors influencing the improvement in the nutritional quality of feed ingredients. Research by Koni et al. [12] showed that fermenting banana peels with palm sap for 6 days reduced the dry matter content from 86.69% to 82.38%, crude fiber from 13.65% to 11.55%, and ash content in banana peels from 12.69% to 13.29%. Furthermore, it increased the crude protein content from 5.73% to 6.72%.

This research was aimed to assess the content of dry matter, crude fiber, and ash in rice bran with the addition of palmyra sap (nira lontar) during different fermentation durations.

2 Materials and methods

2.1 Materials

The experiment was conducted at Politeknik Pertanian Negeri Kupang, East Nusa Tenggara Province, Indonesia. The materials used in this study consist of rice bran, palmyra sap (nira lontar), and distilled water. Palmyra sap (nira lontar) was obtained from lontar palm tree tappers in Lasiana, Kupang City. Aquades was used for pH measurement and rinsing the electrodes in the pH meter 5.

2.2 Research procedure

This research is divided into three parts: the preparation phase, the fermentation phase, and the analysis phase of dry matter, crude fiber, and ash content.

1. The Stage of preparation. The preparation phase was carried out for rice bran, palmyra sap (nira lontar), and the containers used as silos. The preparation procedure is as follows: Rice bran was sifted to separate the bran from the husk. The rice bran was analyzed for its dry matter content in the Laboratory, which was found to be 91.59%, with a moisture content of 8.41%. The rice bran was then placed into envelopes and sterilized using an autoclave at a pressure of 121 atm for 15 minutes. The palmyra sap (nira lontar) purchased directly from the tappers of lontar palm trees in Lasiana was immediately pH-tested using a pH meter after being tapped from the lontar palm tree for 2 hours. The containers were subsequently sterilized through a steaming process for 15...
minutes.

2. **Fermentation Phase.** The fermentation of rice bran refers to the procedure as described by Koni et al. [13], where all the materials that were fermented were prepared to have a moisture content of 35%, while the use of palmyra sap (nira lontar) was at 20% of the moisture content of the rice bran. The fermentation was carried out following these steps: Rice bran was weighed and then placed in a tray. Palmyra sap (nira lontar) was measured at 20% of the dry matter and placed in a provided container. Subsequently, the water content was measured, and it was mixed into the palm sap, which was then blended with the rice bran until homogeneous. Two grams of the resulting mixture were taken for pH measurement. The pH measurements were based on Bernardes et al. [14] and involved taking 2 grams of fermented rice bran, mixing it with 10 ml of distilled water, stirring, and then measuring the pH. Subsequently, the mixture from step 2 was placed in a container (jar) while being compacted. The surface of the mixture was covered with a clear plastic sheet and the jar lid was closed. The outer part of the jar lid was sealed with tape and stored in a place that was not exposed to direct sunlight. Fermentation was conducted in accordance with the specified treatment duration, which included 0, 3, 6, and 9 days. For the DN0 (without fermentation) following the mixing of fermentation materials, pH measurement was conducted, followed by weighing, and then the mixture was placed in a 60°C oven for 48 hours. Rice bran was harvested after fermentation according to the treatment. After being dried for 48 hours, the silage was then removed from the oven and weighed to determine the dry weight. The fermented rice bran was then finely ground using a blender and weighed again. Samples of the fermented rice bran were collected, comprising 10% of the silage weight, then packaged and labeled for proximate analysis in the laboratory following [15] guidelines.


2.3 **Experimental design**

This research is an experimental study using rice bran fermented with 20% palmyra sap at different durations. The study was designed using a Completely Randomized Design (CRD) with 4 treatments and 5 replications. The treatments conducted were as follows: DN0: 0 days of fermentation, DN3: 3 days of fermentation, DN6: 6 days of fermentation, DN9: 9 days of fermentation.

2.4 **Statistical analysis**

The nutrient content data obtained in this study were analyzed using Analysis of Variance (ANOVA), and if any significant treatment effects were observed, Duncan's Multiple Range Test [16].
3 Results and discussion

3.1 The effect of fermentation duration on the pH of rice bran added with palmyra sap

Based on the observations of the physical quality of the fermented rice bran, there was no presence of mold. This is likely due to perfect compaction, reducing the entry of oxygen. According to Despal et al. [17], lactic acid production lowers the pH, thereby inhibiting the growth of mold.

Table 1. The initial pH and final pH of fermented rice bran with the addition of palmyra sap at different fermentation durations.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Initial pH</th>
<th>pH after fermentation</th>
</tr>
</thead>
<tbody>
<tr>
<td>DN0</td>
<td>6.25</td>
<td>6.25</td>
</tr>
<tr>
<td>DN3</td>
<td>6.02</td>
<td>4.85</td>
</tr>
<tr>
<td>DN6</td>
<td>6.27</td>
<td>4.27</td>
</tr>
<tr>
<td>DN9</td>
<td>6.30</td>
<td>4.09</td>
</tr>
</tbody>
</table>

Note: DN0: without fermentation, DN3: 3 days fermentation, DN6: 6 days fermentation, and DN9: 9 days fermentation

The measurement results show a decrease in pH after fermentation. The pH range obtained in this study falls within the "very good" category. This is likely because silage can reach an anaerobic condition, which suppresses fungal growth and leads to a decrease in pH. The pH values decreased in the 3, 6, and 9-day treatments. This occurred due to the presence of organic acids such as lactic acid produced by lactic acid bacteria (LAB) during the fermentation process of the rice bran. Rice bran with the addition of palmyra sap produced a higher lactic acid content than rice bran without sap addition, which was fermented for 6 days [13]. The production of lactic acid contributes to the pH reduction. The lactic acid content generated during the fermentation process acts as a preservative, thus reducing the growth of spoilage microorganisms. According to Despal et al. [17], lactic acid bacteria are capable of lowering silage pH.

3.2 The effect of fermentation duration on the dry matter content of rice bran added with palmyra sap

The data on the different effects of fermentation duration on the dry matter content of rice bran added with palmyra sap can be seen in Table 2. Based on the analysis of variance, the fermentation duration did not have a significant effect (P>0.05) on the dry matter content of rice bran added with palmyra sap. This is likely because the fermented material was prepared with the same dry matter content, which was 65%. Consequently, the dry matter content remained unchanged after fermentation. This is because there was no damage or degradation to the dry matter, resulting in no decrease in dry matter content. The treatment of adding rice bran to cabbage vegetable waste silage had a significant effect (P<0.05) on increasing the dry matter content while [1]
Table 2. Effects of fermentation duration on the dry matter, crude fiber, and ash content of rice bran added with palmyra sap.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>Parameter</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Dry Matter (%)</td>
<td>Crude Fiber (%)</td>
</tr>
<tr>
<td>DN0</td>
<td>39.29±1.69</td>
<td>34.02±3.47c</td>
</tr>
<tr>
<td>DN3</td>
<td>47.26±1.83</td>
<td>26.82±1.79a</td>
</tr>
<tr>
<td>DN6</td>
<td>42.57±1.84</td>
<td>27.88±2.91b</td>
</tr>
<tr>
<td>DN9</td>
<td>44.31±4.10</td>
<td>28.85±2.31b</td>
</tr>
<tr>
<td>P value</td>
<td>0.309</td>
<td>0.003</td>
</tr>
</tbody>
</table>

Note: DN0: without fermentation, DN3: 3 days fermentation, DN6: 6 days fermentation, and DN9: 9 days fermentation. a b c, means ± standard deviation followed by different letters in the same column indicate significant differences (p<0.05).

3.3 The influence of fermentation duration on the crude fiber content of rice bran added with palmyra sap

The data regarding the influence of fermentation duration on the crude fiber content of rice bran added with palmyra sap is presented in Table 2. The analysis of variance results showed a highly significant (P<0.01) effect of fermentation duration on the crude fiber content of rice bran. Fermentation durations of 3, 6, and 9 days were observed to reduce the crude fiber content. This is likely because microorganisms such as lactic acid bacteria in the fermentation process of rice bran added with palmyra sap produce cellulase enzymes, which can reduce crude fiber. Chayaningsih [18] stated that several lactic acid bacteria were isolated from palmyra sap in Kupang, East Nusa Tenggara, including Leuconostoc mesenteroides, Leuconostoc pseudomesenteroides, Lactobacillus plantarum, and Lactobacillus fermentum. [19] mentioned that lactic acid bacteria are capable of producing enzymes that degrade fiber, such as cellulase and xylanase. The results of Safitri et al. [20] indicated that the fermentation of rice bran using EM4 can reduce the crude fiber content of rice bran compared to non-fermented rice bran.

Based on the results of the Duncan analysis, the DN0 treatment had a higher (P<0.05) crude fiber content than the DN3, DN6, and DN9 treatments. The DN3 treatment significantly differed (P<0.05) from the DN6 and DN9 treatments, but There was no significant difference (P>0.05) between the DN6 and DN9 treatments. In the 3-day fermentation duration, the crude fiber content was the lowest compared to the other treatments. This is likely because a 3-day fermentation period is the optimum time for microorganisms to produce cellulase enzymes, allowing the crude fiber to be broken down into easily digestible compounds. At 6 and 9 days, it may be due to a reduction in nutrients in the substrate, leading to a decrease in microorganism activity and limited fiber degradation. According to the findings of Safitri et al.[20], a fermentation duration of 36 hours can reduce the crude fiber content in rice bran fermented with EM4.

The reduction in crude fiber is suspected to be due to the microorganisms present in palm sap being able to digest the crude fiber in rice bran. This study's results are consistent with the findings of [20], where the average crude fiber content of banana peels fermented with palm sap decreased from 18.7% to 11.55%.
3.4 The effect of fermentation duration on the ash content of rice bran added with palmyra sap

The data regarding the effect of fermentation duration on the ash content of rice bran added with palmyra sap is presented in Table 2. The analysis of variance results indicate that fermentation duration significantly affects ($P<0.05$) the ash content of rice bran added with palmyra sap. It can be observed that the ash content decreases in the 3-day treatment. This is likely because lactic acid bacteria utilize mineral contents such as calcium and phosphorus from palmyra sap and rice bran during the fermentation process, resulting in a lower ash content. According to [20], when inorganic matter (ash) decreases, it is likely that the content of organic matter containing nutrients increases. In the 6 and 9-day treatments, there is an increase in ash content due to the degradation of organic matter during the fermentation process, as a result of microbial activity.

The results of the Duncan test indicate that the 3-day fermentation duration has a significantly lower ($P<0.05$) ash content compared to the other treatments. The 3-day treatment has a significantly lower ($P<0.05$) ash content than the 6 and 9-day treatments. There is no significant difference ($P>0.05$) between the 6 and 9-day treatments. The low ash content in the 3-day fermentation duration is likely due to microorganisms using nutrients, including ash, for their growth, leading to a decrease in ash content in the substrate. Meanwhile, in the 6 and 9-day treatments, there is an increase in ash content because a longer fermentation duration results in a reduction in organic matter caused by microbes. Beneficial microbes are sourced from additives in the combustion process, and their inorganic elements are retained [21].

4 Conclusions

Based on the results and discussion, the fermentation duration did not affect the dry matter content but had a significant impact on the crude fiber and ash content in rice bran with palmyra sap addition. Considering the lowest crude fiber content observed, a 3-day fermentation period appears to be the most effective treatment for rice bran supplemented with palmyra sap.

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References